REMARKS

Claims 1-32 are pending in the case, of which claim 32 is withdrawn from consideration. In the last office action, non-elected claims 33-51 have already been cancelled. Claims 1-31 stand rejected. For the reasons stated below, Applicant respectfully requests withdrawal of the finality of the office action and requests reconsideration of the §103(a) rejection of the claims.

In the present office action, the Examiner maintains his rejection of the claims based primarily on Applicant's Admitted prior art and the "Bagley" reference. In the December 20, 2004, response to office action filed by the Applicant, Applicant discussed the Bagley reference in detail and provided at least two compelling reasons why the Bagley reference cannot be relied upon as a proper prior art reference for establishing the obviousness rejection of the claimed invention: **that Bagley is not an analogous prior art and that Bagley actually teaches away from the claimed invention.** However, in the Examiner's office action, the Examiner did not address the merits of these arguments. Therefore, in the present submission, Applicant presents more detail explanations to the Examiner to aid the Examiner in understanding why Bagley cannot be relied upon as a basis for the §103(a) rejection of the present claims.

1. The § 103(a) rejection of Claims 1-31 was improper.

In the present office action, claims 1-4, 6, 8, 10-13 and 23-30 have been rejected under §103(a) as being unpatentable over Applicant's Admission (Admitted Prior Art) in view of Bagley et al. (U.S. Patent No. 5,924,845; hereinafter "Bagley").

Furthermore, claims 5, 15-17, 19, 21, 22 and 31 have been rejected under §103(a) as being unpatentable over the Admitted Prior Art in view of Bagley and further in view of Fretigny et al. (U.S. Patent No. 6,349,591).

Finally, claims 7, 9, 11-22 and 30 have been rejected under §103(a) as being unpatentable over the Admitted Prior Art in view of Bagley and further in view of Kirk et al. (U.S. Patent 5,444,244; hereinafter "Kirk").

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The Examiner contends that Applicant describes in Figures 1 and 2 and in pages 1-3 of Applicant's specification an AFM that employs a cantilever that is vibrated "close to one of

its flexural resonances, typically the fundamental resonance frequency." However, Applicant's admitted prior art "does not refer to an 'integer number', or clearly state that that shape is 'selected' to tune the fundamental frequency." (See Office Action, p. 2.) The Examiner further contends that "it would have been obvious that Applicant's described cantilever has a shape that provides for higher resonant frequencies being an integer multiple of a first resonant frequency as Bagley teaches (col. 1, lines 30-35) that cantilevers retain an 'integer multiple' (col. 1, line 32) relationship." (See Office Action, p 2.) Applicant traverses the rejections.

Applicant submits that the §103(a) rejection of the claims is improper at least for the following reasons:

(1) Bagley is not an Analogous Prior Art;

(2) Bagley, when viewed as a whole, teaches away from the claimed invention;

(3) Conflicting Prior Art Teachings in Analogous Prior Art exists; and

(4) Expansive Teachings in Bagley should be discredited.

2. Standard for Establishing Obviousness Rejections

The standard of patentability to be applied in obviousness rejections is enunciated by the Supreme Court in *Graham v. John Deere*, 383 U.S. 1, 148 (1966). (See MPEP §2141.) The four factual inquires enunciated in *Graham* form the background for determining obviousness:

(A) Determining the scope and contents of the prior art;

(B) Ascertaining the differences between the prior art and the claims in issue;

(C) Resolving the level of ordinary skill in the pertinent art; and

(D) Evaluating evidence of secondary considerations.

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As stated in MPEP §2141, "**examiners should apply the test for patentability under 35 U.S.C. 103 set forth in *Graham***". Furthermore, MPEP §2141 goes on to state that when applying 35 U.S.C. 103, the following tenets of patent law must be adhered to:

(A) **The claimed invention must be considered as a whole;**

(B) **The references must be considered as a whole** and must suggest the desirability and thus the obviousness of making the combination;

(C) The references must be viewed without the benefit of impermissible hindsight vision afforded by the claimed invention; and

(D) Reasonable expectation of success is the standard with which obviousness is determined.

3. The Cited References

Bagley describes an apparatus and method for **dynamically absorbing resonant vibration** in jet engine blades and other rotating turbomachine components over all engine speeds. (See Abstract of Bagley.) In the relevant section of Bagley cited by the Examiner (col. 1, lines 22-36), Bagley describes the ***modelling*** a jet engine blade as a cantilever beam:

> For example, a jet engine blade attached to the circumference of a jet engine rotor **may be viewed as a simple cantilever beam** which, as it rotates, experiences various bending forces, such as the aerodynamic forces, or kick, imposed on it each time it rotates past a stator (a stationary blade). As a cantilever beam, **it will have resonant frequencies** representing various bending modes in which it will simply bend, or whip, back and forth, bend with one wave along its length, bend with two waves along its length, and so forth, **with each higher resonant frequency typically being an integer multiple of a first resonant frequency**. If excited by an alternating force having an excitation frequency the same as a resonant frequency of the blade, the excitation force will cause increasingly greater blade oscillations in that vibration mode...(emphasis added).

However, Bagley went on to state that (col. 1, line 66 to col. 2, line 5):

> **Modern jet engine blades are better modeled as plates than as beams**, so that they have more complicated vibration modes, including, in addition to conventional bending modes, torsion modes and chordwise bending modes. All these vibration modes combine to determine **the actual resonant frequencies** for a particular jet engine or other turbine or turbomachine blade. (Emphasis added)

Thus, when Bagley is viewed as a whole, Bagley describes the ***theoretical*** characteristics of the jet engine blade when the jet engine blade is modelled as a cantilever beam. While

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Bagley makes the broad statement that for such a cantilever beam, each higher resonant frequency is typically an integer multiple of a first resonant frequency, Bagley does not provide the boundary conditions (e.g. the geometry of the cantilever) for arriving at such a conclusion and also does not quantify the "integer multiple" relationship. In Bagley case where a jet engine blade is concerned, an "integer multiple" can mean anything within +/- 20% of an integer value. Importantly, Bagley recognizes that the ***actual*** resonant frequencies for a particular jet engine depend on many factors.

Bagley is directed to reducing resonant vibration in jet engine blades Bagley went on to describe methods for providing vibration absorption or damping, ultimately proposing a particular centrifugal pendulum absorber for attenuating resonant vibration in jet engine blades over all engine speeds. (See generally, Bagley, Background of the Invention.)

The Examiner relied on Fretigny for describing the use of a tapered shape cantilever and on Kirk for describing the use of notches in cantilevers. However, because neither Fretigny nor Kirk cure the deficiency of Bagley, the removal of Bagley reference is sufficient to remove the §103(a) rejection of the claims.

4. Bagley is Not an Analogous Prior Art

Under the first prong of the Graham factual inquires, the scope and content of the prior art must be determined. **To rely on a reference under 35 U.S.C. 103, it must be analogous prior art.** See MPEP §2141.01(a). "The examiner must determine what is 'analogous prior art' for the purpose of analyzing the obviousness of the subject matter at issue." *Id.*

"In order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be **in the field of applicant's endeavor** or, if not, then be **reasonably pertinent to the particular problem** with which the inventor was concerned." *In re Oetiker*, 977 F.2d 1443, 1446 (Fed. Cir. 1992), emphasis added. The court in *In re Oetiker* further noted that:

> [I]t is necessary to consider 'the reality of the circumstances',... – in other words, common sense – in deciding in which fields a person of ordinary skill would reasonably be expected to look for a solution to the problem facing the inventor...The combination of elements from non-analogous sources, in a manner that reconstructs the applicant's invention

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only with the benefit of hindsight, is insufficient to present a *prima facie* case of obviousness. 977 F.2d at 1447.

Applicant submits that Bagley, directed to reducing resonant vibration in jet engine blades, is **not an "analogous prior art"** and therefore cannot be relied upon to form the basis of the §103(a) rejection of the present claims.

Bagley is concerned entirely with an apparatus and method for absorbing or suppressing vibration in rotating machinery, such as jet engine blades. Meanwhile, Applicant's claimed invention is directed to cantilevers for use in atomic force microscopy which enables imaging at higher harmonic modes of the excitation frequency. By recitation of a cantilever including a cantilever arm and a probe tip, and further, by recitation of the cantilever being used in an atomic force microscope in claim 1, Applicant made clear that the cantilever as claimed is a microscopic structure, far different from a jet engine blade or other rotating machinery.

Bagley is not an analogous prior art because reducing resonant vibration in jet engine blades is not in the field of Applicant's endeavor which concerns cantilevers for atomic force microscopy. Reducing resonant vibration in jet engine blades is not reasonably pertinent to the particular problem with which the inventors of the present application were concerned, which is to make a cantilever for atomic force microscopy where the resonant vibrations of the cantilever are to be amplified. There is no suggestion or motivation in Bagley that it's teachings can be combined with Applicant's Admitted prior art to form an improved cantilever for atomic force microscopy.

Even more importantly, Bagley actually teaches away from the claimed invention.

5. Bagley Teaches Away from the Claimed Invention

Bagley, directed to reducing resonant vibration in jet engine blades, teaches away from the claimed invention. **"A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention."** *W.L. Gore & Associates, Inc. v. Garlock, Inc.* 721 F.2d 1540 (Fed. Cir. 1983); emphasis added. Bagley is concerned with reducing or suppressing vibration for a particular vibration mode for jet engine blades. When **Bagley is viewed as a whole**, the teaching in Bagley is directly opposite to the purpose of the claimed invention where the vibration of a cantilever arm for a

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higher order mode is to be enhanced by tuning either the resonance frequency of the selected higher order mode or the fundamental resonance frequency to an integer ratio. Applicant explains the purpose of the claimed invention in paragraph [0033] of the specification as follows:

> Specifically, the harmonic cantilever of the present invention enables TM-AFM imaging at higher harmonics by **mechanically amplifying the higher eigenmode vibrations** and thereby increasing the resolution of imaging at higher order modes. In one embodiment, the ratio of the fundamental resonance frequency and the resonance frequency of a higher eigenmode of the harmonic cantilever of the present invention is tuned to be an integer value or near integer value to **enable amplification of the higher eigenmode vibrations.** (Emphasis added.)

Thus, Bagley, by describing adsorption or suppression of resonant vibrations in jet engine blades, actually teaches away from the claimed invention of claim 1 where the resonant vibrations of the inventive cantilever are actually amplified.

6. Conflicting Prior Art Teachings in Analogous Prior Art exists

While Bagley describes that a jet engine blade can be modelled as a cantilever beam where the cantilever beam "will have resonant frequencies representing various bending modes...with each higher resonant frequency typically being an integer multiple of a first resonant frequency," Bagley is simply describing the theoretical or expected characteristics of **a jet engine blade modelled as a cantilever beam**. Bagley does not describe the boundary conditions for evaluating the resonant frequencies of the jet-engine-blade modelled as a cantilever beam. Therefore, it is impossible to determine if the expansive statement made by Bagley regarding the "integer multiple" relationship of the resonant frequencies is applicable for other cantilever beam system. **In fact, the expansive statement made by Bagley does not apply at all to cantilever systems used in atomic force microscope.**

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To aid in the Examiner's understanding of cantilevers and the calculation of their associated resonant frequencies, Applicant submits herewith a 1996 technical paper entitled "Vibrations of free and surface-coupled atomic force microscope cantilevers: Theory and

experiment," of U. Rabe et al., Rev. Sci. Instrum. 67(9), September 1996, 10 pp. ("the Rabe paper"). The following points can be summarized from the Rabe paper:

(1) The Rabe paper provided a detail study of "rectangular" atomic force microscope (AFM) cantilevers. Rabe explained that the calculation of the resonance frequencies of AFM cantilevers is governed by the shape and geometry of the cantilevers (see first paragraph under section II.A.) where triangular cantilevers require numerical calculations and cantilevers with homogeneous cross section, such as rectangular ones, have simpler solutions.

Therefore, the resonant frequency relationship of an AFM cantilever has to be determined for each cantilever geometry. Each derived relationship may not apply to other cantilever geometry.

(2) The Rabe paper describes in detail the boundary conditions for calculating the vibration modes for rectangular AFM cantilevers. (See FIG. 1 of paper.) Equation (6) in the Rabe paper gives the equation for calculating the resonance frequency f_n belonging to each wave number k_n. Wave number k_n can be solved for using Equation (5). As can be observed from Equations (5) and (6), for each n, the resonant frequency f_n is not a simple integer multiple of the first resonant frequency.

(3) Table II of the Rabe paper provides theoretical resonant frequencies f_n calculated using Equations (5) and (6) and experimentally determined eigenfrequencies f_{exp} of four rectangular AFM cantilevers. One can readily observe that the relationships between the resonant frequencies, theoretical or experimentally obtained, are not simple integer multiples.

Applicant further refers the Examiner to the textbook by Bharat Bhushan, entitled "Springer Handbook of Nanotechnology," Springer-Verlag 2004, Berlin, Germany, ISBN 3-540-01218-4. The relevant page of the Bhushan textbook is enclosed herewith for the Examiner's reference. In the Bhushan textbook, an equation for the resonant frequencies for cantilever beams is given as equation (11.34) . As can be observed from equation (11.34), the relationship between the resonant frequencies in the fundamental mode, the second mode and the nth mode is not a simple an integer multiple of the fundamental mode.

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So while Bagley makes an expansive statement regarding the integer multiple relationship of a cantilever beam's resonant frequencies, **Bagley's statement is only applicable for his situation which is a cantilever beam used to model a jet engine blade.** Bagley does not provide the boundary conditions for calculating the resonant frequencies for his cantilever beam and therefore, there is no way to know if the resonant frequency relationship of his cantilever beam model can be applied to other cantilever beams. In fact, **Bagley's expansive teachings have no application in AFM cantilevers.** As shown by the Rabe paper, for a rectangular AFM cantilever with a homogenous cross-section, the resonance frequencies of the cantilever in fact do not have an integer multiple relationship.

MPEP §2143.01 states that:

> The test for obviousness is what the combined teachings of the references would have suggested to one of ordinary skill in the art, and all teachings in the prior art must be considered to the extent that they are in analogous arts. **Where the teachings of two or more prior art references conflict, the examiner must weigh the power of each reference to suggest solutions to one of ordinary skill in the art, considering the degree to which one reference might accurately discredit another.** *In re Young*, 927 F.2d 588, 18 USPQ2d 1089 (Fed. Cir. 1991)

In the present case, there are two conflicting prior art references: Bagley and Rabe. The Bagley reference is not an analogous prior art and does not provide support and explanation for its statement regarding resonance frequencies of cantilevers. The Rabe paper is analogous prior art and explains in detail the calculation of the resonance frequencies for rectangular AFM cantilevers. A reasonable Examiner would have agreed the Rabe paper accurately discredits the Bagley reference. The Bagley reference thus cannot be relied upon as a reference for establishing an obviousness rejection of the present claims.

7. Expansive Teachings in Bagley should be discredited.

In *In re Bell* (991 F.2d 781 (1993)), the Federal Circuit cautioned that a "prior art reference's expansive predictions about its own significance should not always be taken at face value." While Bagley mentions that a cantilever beam modelling a jet engine blade can have resonant frequencies that have an integer multiple relationship, Bagley actually teaches away from the claimed invention by suggesting that such vibration mode in a jet engine blade

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should be reduced or suppressed. **Bagley nowhere suggests how to apply its teachings to AFM cantilevers where the resonant vibrations of the cantilevers are to be amplified.** Absent any suggestion or motivation to apply Bagley to the Admitted Prior Art, the Examiner has not established that the claimed invention would have been obvious over the combination of Bagley and the Admitted prior art.

8. The Claims

Claim 1

Claim 1, as filed, is patentable over the Admitted Prior Art in combination with Bagley at least because the combination does not teach or suggest a "cantilever for use in an atomic force microscope... the cantilever arm **has a shape selected to tune the fundamental resonance frequency** of the fundamental mode **or a resonance frequency of a selected higher order mode** so that the resonance frequency of the selected higher order mode and the fundamental resonance frequency **has an integer ratio**" (emphasis added).

The Examiner agreed that the Admitted Prior Art does not teach or suggest the aforementioned limitation of claim 1. For at least the reasons stated above, Bagley cannot be relied upon to establish the §103(a) rejection of claim 1.

As Applicant explains in paragraph [0035] of the specification:

> **In conventional cantilevers, the resonance frequencies of the higher order modes are located arbitrarily in the frequency domain.** As a result, the higher order harmonics cannot excite the higher resonance frequencies efficiently. However, **the harmonic cantilever of the present invention is configured so that the resonance frequency of a higher order mode is an integer multiple of the fundamental resonance frequency.** Since the higher harmonics are located at integer multiples of the driving frequency that is at or near the fundamental resonance frequency, **efficient resonant excitation can occur** when the ratio of the frequencies of a higher order mode and fundamental mode is tuned to an integer value.

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Thus, Applicant explained that a conventional cantilever does not have resonant frequencies that are integer ratio of each other. Applicant's claimed invention provides for the tuning of the actual resonant frequencies so that a selected high order mode is an integer multiple of the actual fundamental resonant frequency. Bagley, in a entirely different field of

endeavor and teaching away from the claimed invention, does not teach or suggest the limitation of "the cantilever arm ha[ving] a shape selected to tune the fundamental resonance frequency of the fundamental mode or a resonance frequency of a selected higher order mode so that the resonance frequency of the selected higher order mode and the fundamental resonance frequency has an integer ratio," as recited in claim 1.

Claims 2-31

Claims 2-31, dependent upon claim 1, are patentable over the Admitted Prior Art and Bagley, alone or in combination, for at least the same reasons that claim 1 is patentable. Fretigny and Kirk fail to cure the deficiency of the Admitted Prior Art and Bagley. Thus, claims 2-31 are patentable over the Admitted Prior Art and the cited references.

For the above reasons, withdrawal of the §103(a) rejection of claims 1-31 is respectfully requested.

CONCLUSION

After the present amendment, claims 1-32 are pending in the present application. For the above-stated reasons, Applicant respectfully requests withdrawal of the §103(a) rejections of the claims. Passage of the case to allowance is respectfully requested. If the Examiner would like to discuss any aspect of this application, the Examiner is invited to contact the undersigned at (408) 382-0480.

Certification of Facsimile Transmission

I hereby certify that this paper is being facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature — March 11, 2005 Date

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